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(54) **Producing metal patterns on a substrate**

Herstellen von Metallmustern auf einem Substrat

La formation de configurations de métal sur un substrat

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Description

The present invention relates to the fields of metal patterning and electronics, and more particularly, to the patterning of thin layers of metal.

In the electronic arts, a common method of providing a circuit pattern is to form a layer of metal on an electrically insulating substrate, deposit a layer of photoresist over the the metal, pattern the photoresist photolithographically and etch the metal where it is not protected by the photoresist in order to leave the metal present in the pattern of the retained photoresist. This etching technique is limited in its inability to maintain very fine line lithography due to photoresist lift-off or deterioration, undercutting and other phenomena during etching.

An alternative technique is to electroplate metal on the portions of the initial metal layer which are not covered by the photoresist. Such a plating process is normally completed by removing the remaining photoresist and etching away the initial metal layer with an etchant which does not attack the electroplated metal. The use of this plating technique to form gold, chrome or nickel electroplated conductors is normally ineffective because the electroplating bath attacks the photoresist vigorously causing deterioration and lift-off of the photoresist which results in plating in areas intended to be kept plating-free.

A high density interconnect (HDI) structure or system which has been developed by General Electric Company requires patterning of metal conductors disposed on dielectric layers in order to form the interconnections among the integrated circuit chips of a system it is being used to interconnect. This high density interconnect structure offers many advantages in the compact assembly of electronic systems. For example, an electronic system such as a micro computer which incorporates 30-50 chips can be fully assembled and interconnected on a single substrate which is 2 inches long by 2 inches wide by .050 inch thick.

Briefly, in this high density interconnect structure, a ceramic substrate such as alumina which may be 100 mils thick and of appropriate size and strength for the overall system, is provided. This size is typically less than 2 inches square, but may be made larger or smaller. Once the position of the various chips has been specified, individual cavities or one large cavity having appropriate depth at the intended locations of differing chips, is prepared. This may be done by starting with a bare substrate having a uniform thickness and the desired size. Conventional, ultrasonic or laser milling may be used to form the cavities in which the various chips and other components will be positioned. For many systems where it is desired to place chips nearly edge-to-edge, a single large cavity is satisfactory. That large cavity may typically have a uniform depth where the semiconductor chips have a substantially uniform thickness. Where a particularly thick or a particularly thin component will be placed, the cavity bottom may be made respectively deeper or shallower to place the upper surface of the corresponding component in substantially the same plane as the upper surface of the rest of the components and the portion of the substrate which surrounds the cavity. The bottom of the cavity is then provided with a thermoplastic adhesive layer which may preferably be polyetherimide resin available under the trade name ULTEM® 6000 from the General Electric Company. The various components are then placed in their desired locations within the cavity, the entire structure is heated to about 300°C which is above the softening point of the ULTEM® polyetherimide (which is in the vicinity of 235°C) and then cooled to thermoplastically bond the individual components to the substrate. Thereafter, a polyimide film which may be Kapton® polyimide, available from E.I. du Pont de Nemours Company, which is ≈0.0005-0.003 inch (≈12.5-75 microns) thick is pretreated to promote adhesion by reactive ion etching (RIE). The substrate and chips are then coated with ULTEM® 1000 polyetherimide resin or another thermoplastic and the Kapton film is laminated across the top of the chips, any other components and the substrate with the ULTEM® resin serving as a thermoplastic adhesive to hold the Kapton® in place. Thereafter, via holes are provided (preferably by laser drilling) in the Kapton® and ULTEM® layers in alignment with the contact pads on the electronic components to which it is desired to make contact. A metallization layer which is deposited over the Kapton® layer extends into the via holes and makes electrical contact to the contact pads disposed thereunder. This metallization layer may be patterned to form individual conductors during the process of depositing it or may be deposited as a continuous layer and then patterned using photoresist and etching. The photoresist is preferably exposed using a laser to provide an accurately aligned conductor pattern at the end of the process. Additional dielectric and metallization layers are provided as required in order to provide all of the desired electrical connections among the chips.

Good adhesion of the metal conductors to the underlying dielectric and good adhesion of each dielectric layer to both the underlying metal and the underlying dielectric is necessary for proper fabrication of these high density interconnect circuits.

This high density interconnect structure, methods of fabricating it and tools for fabricating it are disclosed in U.S. Patent 4,783,695, entitled "Multichip Integrated Circuit Packaging Configuration and Method" by C.W. Eichelberger, et al.; U.S. Patent 4,835,704, entitled "Adaptive Lithography System to Provide High Density Interconnect" by C.W. Eichelberger, et al.; U.S. Patent 4,714,516, entitled "Method to Produce Via Holes in Polymer Dielectrics for Multiple Electronic Circuit Chip Packaging" by C.W. Eichelberger, et al.; U.S. Patent 4,780,177, entitled "Excimer Laser Patterning of a Novel Resist" by R.J. Wojnarowski et al.; U.S. Patent Application Serial No. 249,927, filed September 27, 1989, en-

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There is a continuing need for improved metal patterning techniques and for enhanced inter-dielectric layer adhesion.

Accordingly, the present invention seeks to provide an improved metal patterning technique which enables copper, gold, chrome and nickel patterns to be formed with high definition and reliability.

The present invention also seeks to provide an improved technique for producing high definition conductor patterns by patterned removal of a uniform conducting layer.

The present invention also seeks to provide a laser ablation technique for patterning conductive layers.

The present invention also seeks, in one embodiment thereof, to provide a metal patterning technique in which two layers of different metals burn off together during laser patterning.

The present invention also seeks to provide a laser metal patterning technique which is useful on high thermal conductivity substrates.

US-A-4,826,785 describes a metallic interconnect including a fuse portion that is readily vaporized upon exposure to the radiant energy of a laser. A layer of optically absorptive material is formed on top of an aluminum based metallic interconnect and together they are formed by a photolithographic and etch technique into a first portion. A low energy laser having a Gaussian energy distribution focused on the absorptive layer produces heat in the absorptive layer. The heat is transferred to the underlying aluminum based interconnect. The concentration of energy made possible by the absorptive layer allows the low energy laser to blow the fuse thereby producing an electrical open in the interconnect without damaging surrounding silicon substrate and/or polysilicon structures below or nearby the metal fuse.

According to the invention, there is provided a method of producing a desired metal pattern on a surface of a substrate comprising; depositing a layer of a first metal on said substrate, one of said substrate and the resulting surface of said first metal having a low thermal conductivity; depositing a layer of a second, ultraviolet light absorbing metal on said first metal without breaking vacuum; exposing said second metal to intense ultraviolet light in accordance with said desired pattern to ablate at least said second metal.

In accordance with one embodiment, a first layer of a thermally inefficient, reactive metal is deposited on an electrically insulating substrate and a second ultraviolet light absorbing metal is deposited on that first metal. The resulting structure is scanned with a UV laser having sufficient power to ablate the first and second metals together to remove them from the substrate in a pattern which is determined by the scanning pattern of the laser beam, while leaving them on the substrate elsewhere. Where the substrate is a polymer and the first layer is titanium or chrome and the second layer is copper, the portion of the polymer surface from which the metals were ablated is greatly roughened. If a subsequent dielectric layer is formed on top of this roughened surface by applying a liquid precursor and drying or curing it, then adhesion between the two layers is greatly enhanced by a resulting interlocking of the newly deposited dielectric layer with the roughened surface of the substrate.

In accordance with another embodiment, where the substrate is highly thermally conducting, an initial layer of a thermally inefficient metal such as titanium, chrome, stainless steel and so forth is disposed on the substrate prior to deposition of a subsequent layer of UV absorbing metal. This layer of thermally inefficient metal is made thick enough to cause the combined structure to act as a thermally inefficient substrate. The UV absorbing metal is then ablated from the surface of the thermally inefficient metal to create a metal pattern with good definition. The remaining portions of the second metal layer may then be used as a mask for etching those portions of the first metal which were exposed by the ablation of the second metal. Thereafter, the second metal may be retained or removed, as may be desired.

In accordance with another embodiment, a four layer metal structure may be deposited on a thermally conducting substrate with the third layer being thermally inefficient and the fourth layer being UV absorbing the first and second layers, in the present context, being a part of the substrate. The fourth layer is then patterned by scanning a laser across it. That fourth layer is then used as an etching mask for the third, thermally inefficient layer. The second layer and then the first layer may be etched to provide a conductor pattern of the second layer metal over first layer metal. When the third layer is titanium, the remaining portions of the fourth layer may be removed and additional metal may be electroplated on the exposed portions of the second layer without plating on the titanium.

In accordance with another embodiment, a printed circuit having a break in an intended-to-be-continuous trace is repaired by depositing an thermally inefficient metal over the entire surface, depositing a UV absorbing metal over the first metal and then ablating the two deposited layers every place where conductors are not desired. The result is a bridging conductor which connects the two pieces of the trace across the unintended gap

therein.

The invention will now be described in greater detail, by way of example, with reference to the drawings in which:

Figures 1-5 illustrate a sequence of stages in the production of a metal pattern in accordance with one embodiment of the invention;

Figures 6-9 illustrate a sequence of stags in th fabrication of a pattern in accordance with another embodiment;

Figures 10-14 illustrate stages in another embodiment;

Figures 15-17 illustrate stages in an electroplating process;

Figures 18-20 illustrate circuit repair;

Figure 21 illustrates trimming of a resistor to adjust its resistance.

In Figure 1, an electrically insulating substrate 10 is shown in cross-section view. It is desired to form a conductor pattern on the upper surface of this substrate. This substrate may be glass, polymer materials or other relatively thermally inefficient materials. By thermally inefficient, we mean that the material is relatively slow to dissipate localized heat. In this sense, this substrate is distinct from such substrates as alumina and the high thermal conductivity metals such as copper which dissipate heat much more rapidly. The dividing line between thermally efficient and thermally inefficient materials is in part dependent on the energy of the laser beam used to pattern the metal.

As an initial step in the process of forming the conductor pattern, a first, layer of a thermally inefficient metal 22 is formed on the upper surface of the substrate 10 to provide the structure shown in Figure 2. This metal is preferably titanium, but may instead be chrome, nichrome, nickel, stainless steel, magnesium, manganese and so forth. This metal is deposited on the substrate under vacuum or other non-oxidizing conditions by any appropriate method, such as sputtering, thermal evaporation, chemical vapor deposition and so forth. We prefer to deposit this metal layer by sputtering. This layer is preferably from 500 to 1,000Å thick. Subsequently, a layer 24 of a UV absorbing metal which is preferably copper but may also be gold, is deposited on top of the layer 22 without breaking the vacuum in the deposition system to provide the structure illustrated in Figure 3. This copper layer may preferably be deposited to a depth in the range from 500-3,000Å. While thicker layers can be used where higher laser power is available, this thickness is adequate to the purpose, and effective with a laser power of 1-2 watts at 351-363 nm. Other wave lengths may be used with other metals having different absorption spectra. Next, the substrate with its metal coating is mounted in a laser delivery system which is capable of scanning an intense UV light beam across the substrate. We prefer to use an argon ion laser operating at 351 nm, but other frequencies may also be used. The laser is then scanned across the surface of the metal 24 in a pattern which corresponds to the areas in which metal is to be removed as illustrated in Figure 4. The copper absorbs roughly 60% of the UV light incident thereon and is heated to an ablation temperature. Direct ablation of the titanium itself without an overlying absorbing layer is not effective because titanium reflects about 81% of incident 351 nm light. However, there is sufficient thermal coupling between the copper and the titanium that the laser heating of the copper heats the underlying titanium to an ablation temperature which results in the two metals ablating off the substrate together. We prefer to perform this ablation process in an oxidizing atmosphere. This oxidizing atmosphere may be air, air with additional oxygen added to it, pure oxygen, a chlorine containing atmosphere and so forth. We prefer to use air or air plus oxygen. In this oxidizing atmosphere, the titanium and copper burn as they ablate with a sparkling effect similar to that of Fourth of July sparklers. This sparkling extends substantially above the surface of the metal 24.

With this process, we have obtained line spacings of from 2 to 500 microns, while retaining metal patterns of from 2 to 500 microns wide. Wider or narrower lines and spaces may be produced in accordance with the laser beam size and scanning pattern used for the ablation.

A beneficial side effect of this process where the substrate 10 is a polymer is that the portion of the polymer surface from which the metal is ablated becomes roughened with a surface characteristic which looks much like needles standing on their end. This is illustrated in Figure 5 where the portion 12 of the substrate surface 10 from which the metal was ablated has needle-like columns 14 extending roughly vertically. In many instances these columns are mushroom shaped with their upper end larger in cross section than their stem or shank. This roughened surface is a substantial advantage in a high density interconnect structure or other structure where a subsequent dielectric layer is later formed over the metal pattern and the exposed portions of the substrate 10. If that subsequent layer is formed by spinning on or spraying on a liquid precursor which is then converted to a solid dielectric in situ, greatly enhanced adhesion results from the infiltration of the subsequent dielectric layer into the gaps between the needles 14 in the roughened surface of the substrate. This provides improved adhesion for a subsequently formed dielectric layer in two ways. First, it provides an increased contact surface area over which chemical adhesion is provided and second, it provides a rough surface which results in mechanical interlocking of the two

layers which further increases the strength of the bond between the two layers. This mushroom shape of many of the needles further enhances mechanical interlocking of dielectric layers. As a consequence, use of this process to pattern conductor layers in multilayer structures provides additional benefits in providing a more rugged, more thoroughly bonded structure. Thus, this is an adhesion promoting technique which can be applied to a polymer surface even where none of the deposited metal is to be retained on the polymer and its only function is to enable the roughening of the polymer surface during its ablation. This results in a greatly increased surface area.

The combination of these two metals (copper over titanium) results in much sharper patterning than can be obtained with copper alone even where the substrate on which the copper alone is disposed is a substantially poorer thermal conductor than titanium. It is clear that the two metals interact during ablation in accordance with this invention. We therefore refer to this process as reactive ablation. When copper alone is used, no sparkling results, the line edge definition is much poorer and with a polymer substrate the surface of the polymer remains conductive as a result of some of the copper being left behind. It is believed that the copper which is left behind is actually driven into the surface of the polymer. Thus, use of copper alone results in inferior patterning and inferior surface properties for the resulting structure. As is mentioned above, if titanium alone is used, no ablation takes place at these laser powers because not enough energy is absorbed by the titanium to raise it to an ablation temperature. Thus, the combination of the two metals is necessary for high quality definition of the pattern and that high quality is a result of an unexpected interaction between the two metals during the ablation which results in reactive ablation. This interaction affects the removal of the metals themselves from the substrate, and thus is not a reaction which takes place only in the debris which has already left the surface of the substrate, but also involves the metals while they are still disposed on that surface. Since titanium is highly reactive and in the initial structure has been protected from oxidation by the deposition of the copper layer directly over the titanium without breaking the vacuum in the metal deposition system, it is thought that oxidation is taking place at the exposed edge of the titanium as the laser beam heats the copper which in turn heats the titanium. That oxidation then further heats the titanium resulting in the sparkling effect and the improved definition of the ablation pattern as compared to the pattern when copper alone is present. However, whether this is in fact the actual process is not known at this time. Further, the exact chemical and thermal processes going on is unimportant, since our work establishes that whatever processes are in fact taking place produce the beneficial effects of improved pattern definition, result in a non-conductive surface even on polymer substrates and on polymer substrates produce the needles-on-end surface pattern which greatly increases the exposed surface area of the polymer where the metals have been ablated.

In addition to titanium, chrome used as the first or lower metal layer produces a similar sparkling and improvement in pattern definition. Nichrome, nickel, stainless steel, magnesium, manganese and similar metals which are or contain highly reactive elements will produce similar sparkling and improvement in pattern definition.

In accordance with another embodiment of the invention where it is desired to form a metal pattern on a highly thermally conducting substrate such as alumina or a high thermal conductivity metal, the process described above must include the provision of the thermally inefficient layer between the substrate and the ultraviolet absorbing metal in order to enable the laser ablation process to remove the UV absorbing metal. To this end, a layer 112 of a thermally inefficient metal is vacuum deposited on a thermally conducting substrate 100 to provide the structure illustrated in Figure 6. This thermally inefficient metal may be titanium, chromium, stainless steel (as a laminated layer) nichrome, magnesium, manganese or other metals or mixtures or alloys of metals which are thermally inefficient and sufficiently reactive. The layer 112 is made thick enough to render its upper surface thermally inefficient. That is, the poor thermal efficiency of the layer 112 insulates an overlying layer from the thermal efficiency of the substrate 100. Thereafter, a layer 114 of UV absorbing metal is vacuum deposited on the thermally inefficient metal 112 without breaking the vacuum in the deposition apparatus to provide the structure shown in Figure 7. The upper metal layer 114 protects the lower metal layer 112 from oxidation and other chemical reactions. The metal 114 is then ablated by a laser beam 126 as illustrated in Figure 8. This removes the UV absorbing metal 114 in the laser scan pattern and may also remove part of but not all of the thermally inefficient metal 112. At least the lower portion of the thermally inefficient metal remains on the substrate because for a sufficiently thin layer of the thermally inefficient metal, the underlying substrate 100 carries heat away so rapidly that the thermally inefficient layer can not be heated to an ablation temperature. After the ablative patterning of the UV absorbing metal layer 114, the retained portions of that upper metal layer may be used as a mask for chemically etching of the now exposed portions of the thermally inefficient metal 112 to leave portions 120 of the substrate surface metal-free. After such etching of the exposed portions of layer 112, the structure appears as shown in Figure 9.

As an alternative to employing the just described two layer metal structure, a four layer metal structure may be formed prior to laser ablation by successively depositing titanium, copper, titanium and copper to provide a structure of the general type shown in Figure 10. These layers may be -1000Å thick titanium, ~3000Å of deposited copper on which copper is electroplated to

~3mm thick, ~500-1000Å thick titanium and ~500-3000Å thick copper, respectively. In this embodiment the two layers adjacent the substrate technically form part of the substrate as far as the initial ablation is concerned. The upper-most copper layer 118 may then be ablated from the upper surface of the upper titanium layer 116 to leave the copper in the desired pattern for the metallization as shown in Figure 11. This ablation is generally non-reactive in that no burning or sparkling occurs and none of the titanium appears to be removed during the ablation where the titanium layer is ~500-1000Å thick. However, excellent patterning is obtained. This is believed to be in part a result of the impervious nature of the titanium layer. The now exposed portions of the underlying titanium may then be etched with an HF-based etchant to expose the thick copper layer 114 as shown in Figure 12. This etchant needs to be one which etches titanium without etching copper. A copper etch then removes the exposed portions of the lower, thick copper layer 114 and the remaining portions of the upper, thin copper layer 118 to provide the structure shown in Figure 13. A final titanium etch removes the now exposed portions of the lower titanium layer 112 and the portions of the upper titanium layer 116 which protected the copper of the conductor runs during the etching of the thick copper layer 114. This results in the structure shown in Figure 14.

Alternatively, rather than electroplating the first copper layer 114 to thicken it, that copper layer 114 may be left with a thickness of ~6000Å or so and the layers 116 and 118 deposited thereon. The process then follows that described above through the etching of the upper titanium layer 116. Then the retained portions of the upper copper layer 118 are removed from the surface of the titanium by a quick copper etch in ferric chloride which leaves the layer 114 of copper ~3000Å thick as shown in Figure 15. Titanium forms titanium oxide when exposed to air. As a result, the surface of the upper titanium layer 116 is coated with titanium oxide. The resulting titanium oxide layer is sufficiently electrically insulating to prevent electroplating on the titanium, that is, the titanium oxide coated titanium acts as a resist for electroplating. Thus, this structure may then be electroplated in a copper, gold, chrome or nickel electroplating bath to produce plated conductors having the pattern of the exposed copper 114 without depositing the copper gold, chrome or nickel 122 on the titanium portion of the structure as shown in Figure 16. This provides an effective method of forming gold, chrome or nickel plating on copper without the problems of photoresist lifting which have been experienced in the prior art. Following this plating operation, the surface titanium layer may be removed in a HF-based etchant, the portions of the lower copper layer 114 which are not protected by plated metal 122 may be removed in a ferric chloride etchant and the then unprotected portions of the lower titanium layer may be removed in a HF-based etchant. The result is the structure illustrated in Figure 17 in which electroplated copper, gold, chrome or nickel conductors are provided. While this process is highly effective for copper electroplating, its benefits are more pronounced for gold, chromium and nickel electroplating because copper plating baths attack photoresist much more slowly than gold, chromium and nickel electroplating baths do with the result that prior electroplating of copper has been much more successful than prior art electroplating of gold, chromium and nickel.

This metal deposition and ablation technique is also suitable for repairing open conductors in printed circuit type structures such as printed circuit boards, VLSI integrated circuits, wafer scale integrated structures, high density interconnect structures and so forth. Such a printed circuit is shown in perspective view in Figure 18. The substrate 200 may be a single layer of insulating material or may be a multilayer printed circuit structure (including high density interconnect structures) having an insulating upper surface on which the two portions 210 and 212 of an open trace are disposed with an unintended gap 214 therebetween. Where the gap 214 between the conductors 210 and 212 is not discovered until after the formation of a subsequent dielectric layer over those conductors, that dielectric layer needs to be removed at least from the ends of those traces adjacent the gap in order for the metal to-be-deposited to form a good ohmic contact to the conductors 210 and 212.

To effect a repair of this open trace, a first layer 222 of a thermally inefficient, reactive metal such as titanium is deposited over the entire upper surface of the substrate 200 and any conductors thereon. Subsequently, a second layer 224 of a UV absorbing metal such as copper is uniformly deposited over the upper surface. At this stage, as shown in Figure 19, the entire upper surface of the substrate 200 is conductive. The deposited metals are then laser reactive ablated from those portions of the upper surface of the substrate 200 where conductors are not desired, but without ablating the portions of the deposited metals which bridge the gap 214 between the conductors 210 and 212. The retained portion of the deposited metals in the vicinity of the gap between the conductors 210 and 212 serve as a bridging conductor to close the gap, thereby repairing the structure as shown in Figure 20.

This same technique can also be used to provide temporary connections for programming during testing or for other purposes. Such temporary connections can then be removed by etching or by further laser ablation.

This technique is also useful for trimming resistors. In Figure 21, a resistor 310 is disposed on a substrate 300. A two layer metallization 320 is disposed on top of the resistor material as its contacts. These contacts can be initially patterned by photomasking and etching. These contacts are then laser ablated to increase the length of the current path through the resistor material between the two contacts to thereby increase the resistance exhibited by the resistor. Alternatively, all of the patterning of these contacts can be done by laser abla-

tion.

While the invention has been described in detail herein in accord with certain preferred embodiments thereof, many modifications and changes therein may be effected by those skilled in the art. Accordingly, it is intended by the appended claims to cover all such modifications and changes as fall within the scope of the invention which is as defined by the claims.

Claims

1. A method of producing a desired metal pattern on a surface of a substrate comprising :

   depositing a layer of a first metal on said substrate, one of said substrate and the resulting surface of said first metal having a low thermal conductivity;
   depositing a layer of a second, ultraviolet light absorbing metal on said first metal without breaking vacuum;
   exposing said second metal to intense ultraviolet light in accordance with said desired pattern to ablate at least said second metal.

2. The method of Claim 1 wherein said substrate has a low thermal conductivity and said exposing step includes reactively ablating said first and second metals together.

3. The method of Claim 1 wherein said first metal layer is thick enough to render the resulting surface of low thermal conductivity.

4. The method recited in Claim 1, 2 or 3, wherein:

   said first metal is selected from the group consisting of titanium, chromium, magnesium, manganese, nichrome and stainless steel and alloys and mixtures thereof; and
   said second metal is selected from the group consisting of copper and gold and alloys and mixtures thereof.

5. The method recited in Claims 1-4 wherein said substrate is disposed in an oxidizing atmosphere during said exposing step.

6. The method recited in Claim 5, wherein said first and second metals burn off the substrate together during said exposing step.

7. The method recited in Claim 5 wherein said oxidizing atmosphere comprises air.

8. The method recited in Claim 5 wherein said oxidizing atmosphere comprises oxygen.

9. The method recited in any one of Claims 1 to 8, wherein the step of exposing comprises scanning an ultraviolet laser beam across said substrate.

10. The method recited in Claim 3 or any claim appendant directly or indirectly thereto further comprising etching exposed portions of said first metal with an etchant which does not attack said second metal.

11. The method recited in Claim 3 or any claim appendant directly or indirectly thereto, wherein said substrate is electrically conducting, said first metal is titanium and said method further comprises, after the step of exposing, the step of:

    selectively removing said second metal from said titanium;
    allowing the titanium thus exposed to form a surface coating of titanium oxide; and
    electroplating said substrate to build up electroplated metal in those areas from which said metals were ablated without building up electroplated metal on said titanium.

Patentansprüche

1. Verfahren zum Erzeugen eines gewünschten Metallmusters auf einer Oberfläche von einem Substrat, enthaltend:

   Abscheiden einer Schicht aus einem ersten Metall auf dem Substrat, wobei das Substrat oder die entstehende Oberfläche des ersten Metalls eine kleine thermische Leitfähigkeit hat;
   Abscheiden einer Schicht aus einem zweiten, ultraviolettes Licht absorbierenden Metall auf dem ersten Metall ohne Vakuumunterbrechung;
   Bestrahlen des zweiten Metalls mit intensivem ultraviolettem Licht gemäß den gewünschten Muster, um wenigstens das zweite Metall abzutragen.

2. Verfahren nach Anspruch 1, wobei das Substrat eine kleine thermische Leitfähigkeit hat und der Bestrahlungsschritt enthält, daß die ersten und zweiten Metalle zusammen reaktiv abgetragen werden.

3. Verfahren nach Anspruch 1, wobei die erste Metallschicht dick genug ist, um der entstehenden Oberfläche eine kleine thermische Leitfähigkeit zu geben.

4. Verfahren nach Anspruch 1, 2 oder 3, wobei:

   das erste Metall aus der Gruppe ausgewählt ist,

die aus Titan, Chrom, Magnesium, Mangan, Chromnickel und rostfreiem Stahl und Legierungen und Mischungen davon besteht; und das zweite Metall aus der Gruppe ausgewählt ist, die aus Kupfer und Gold und Legierungen und Mischungen davon besteht.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei das Substrat während des Bestrahlungsschrittes in einer oxydierenden Atmosphäre angeordnet wird.

6. Verfahren nach Anspruch 5, wobei die ersten und zweiten Metalle während des Bestrahlungsschrittes gemeinsam das Substrat wegbrennen.

7. Verfahren nach Anspruch 5, wobei die oxydierende Atmosphäre Luft aufweist.

8. Verfahren nach Anspruch 5, wobei die oxydierende Atmosphäre Sauerstoff aufweist.

9. Verfahren nach einem der Ansprüche 1 bis 8, wobei der Bestrahlungsschritt aufweist, daß ein Ultraviolett-Laserbündel über das Substrat abgetastet wird.

10. Verfahren nach Anspruch 3 oder einem direkt oder indirekt davon abhängigen Anspruch, wobei bestrahlte Abschnitte des ersten Metalls mit einem Ätzmittel geätzt werden, das das zweite Metall nicht angreift.

11. Verfahren nach Anspruch 3 oder einem direkt oder indirekt davon abhängigen Anspruch, wobei das Substrat elektrisch leitend ist, das erste Metall Titan ist und das Verfahren weiter, nach dem Bestrahlungsschritt, den Schritt enthält, daß

das zweite Metall von dem Titan selektiv entfernt wird;
das somit bestrahlte Titan einen Oberflächenüberzug aus Titanoxid bilden kann und
das Substrat elektroplattiert wird, um elektroplattiertes Metall auf denjenigen Flächen aufzubauen, von denen die Metalle abgetragen wurden, ohne elektroplattiertes Metall auf dem Titan aufzubauen.

Revendications

1. Procédé de formation d'un motif métallique désiré sur une surface d'un support, qui comprend les étapes consistant à :

déposer une couche d'un premier métal sur ledit support, ledit support ou la surface résultante dudit premier métal présentant une faible conductibilité thermique,
déposer sur ledit premier métal, sans rompre le vide, une couche d'un second métal absorbant les rayons ultraviolets,
exposer ledit second métal à des rayons ultraviolets intenses, conformément audit motif désiré, pour ôter au moins ledit second métal.

2. Procédé selon la revendication 1, dans lequel ledit support présente une faible conductibilité thermique et ladite étape d'exposition comprend l'enlèvement simultané dudit premier métal et dudit second métal par réaction.

3. Procédé selon la revendication 1, dans lequel ladite couche de premier métal est suffisamment épaisse pour rendre la surface résultante faiblement conductrice de la chaleur.

4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel ledit premier métal est choisi parmi le titane, le chrome, le magnésium, le manganèse, le nichrome, l'acier inoxydable, leurs alliages et leurs mélanges, et ledit second métal est choisi parmi le cuivre, l'or, leurs alliages et leurs mélanges.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel ledit support est placé dans une atmosphère oxydante, pendant ladite étape d'exposition.

6. Procédé selon la revendication 5, dans lequel ledit premier métal et ledit second métal sont ôtés ensemble du support par combustion, pendant ladite étape d'exposition.

7. Procédé selon la revendication 5, dans lequel ladite atmosphère oxydante renferme de l'air.

8. Procédé selon la revendication 5, dans lequel ladite atmosphère oxydante renferme de l'oxygène.

9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel l'étape d'exposition comprend le balayage dudit support par un faisceau laser à ultraviolets.

10. Procédé selon la revendication 3 ou l'une quelconque des revendications qui lui sont rattachées directement ou indirectement, qui comprend en outre l'enlèvement des parties exposées dudit premier métal par attaque au moyen d'un produit d'attaque qui n'attaque pas ledit second métal.

11. Procédé selon la revendication 3 ou l'une quelconque des revendications qui lui sont rattachées directement ou indirectement, dans lequel ledit support est électriquement conducteur, ledit premier métal est du titane et ledit procédé comprend en

outre, après l'étape d'exposition, l'étape consistant à ôter sélectivement ledit second métal dudit titane, à laisser se former à la surface du titane ainsi exposée, un revêtement d'oxyde de titane, et à revêtir ledit support par électrolyse de façon à accumuler du métal déposé par électrolyse dans les zones où lesdits métaux ont été ôtés, sans accumuler de métal déposé par électrolyse sur ledit titane.

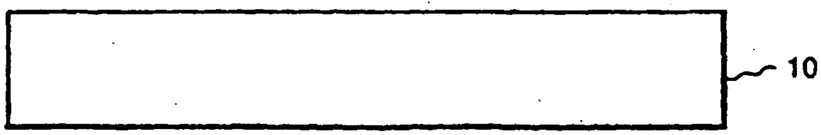

FIG.1

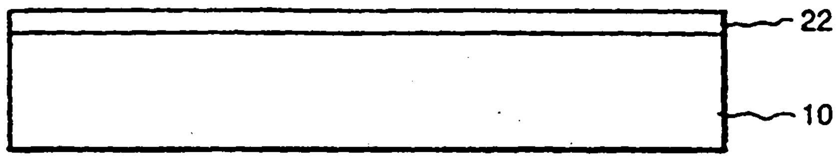

FIG.2

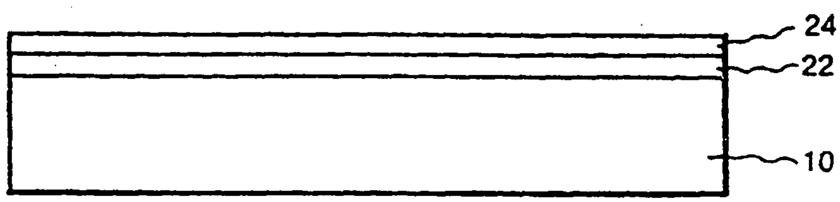

FIG.3

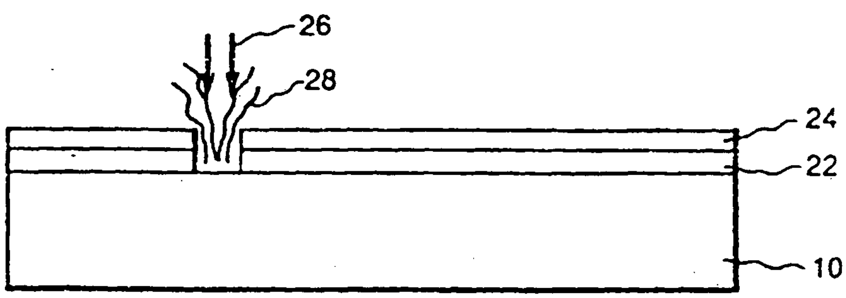

FIG.4

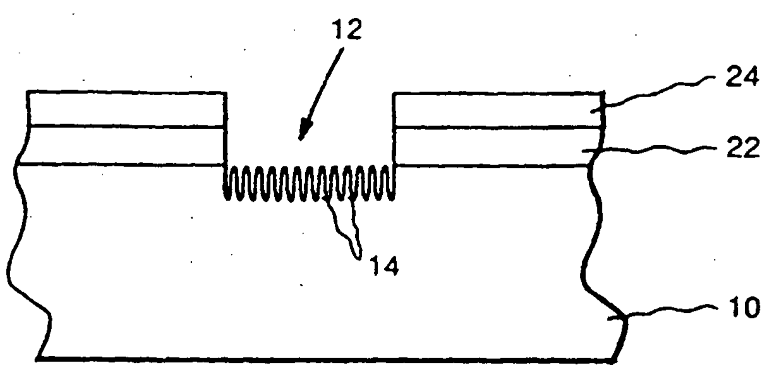

FIG.5

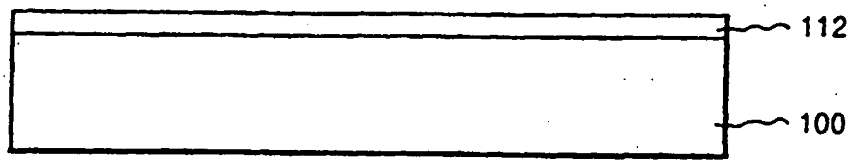

FIG.6

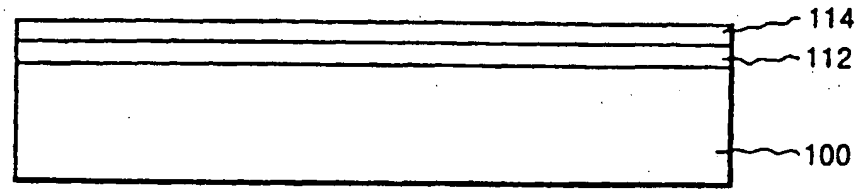

FIG.7

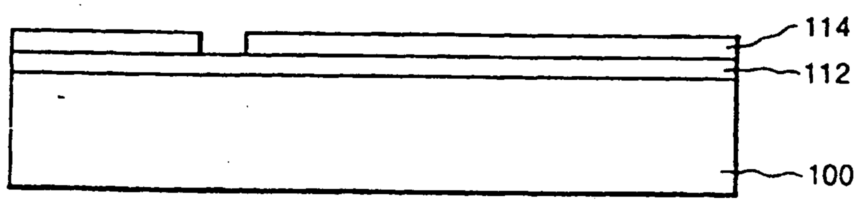

FIG.8

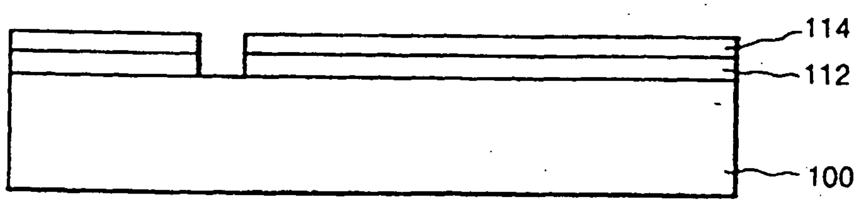

FIG.9

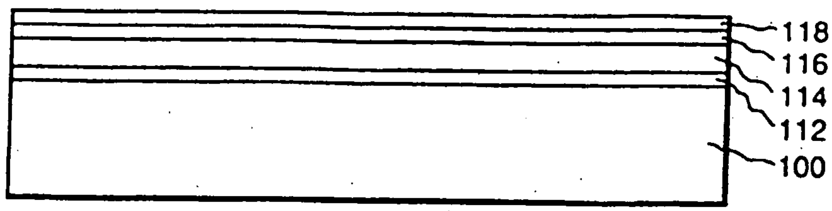

FIG.10

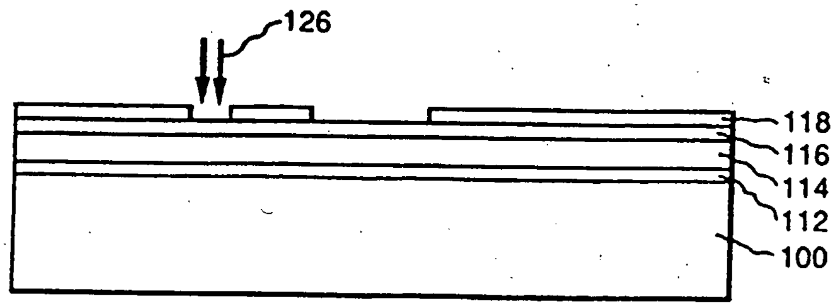

FIG.11

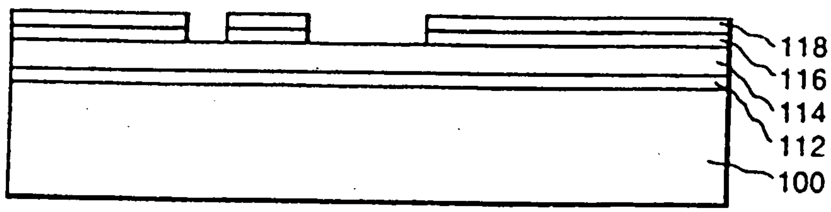

FIG.12

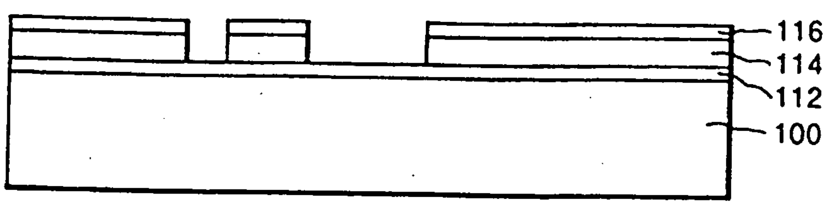

FIG.13

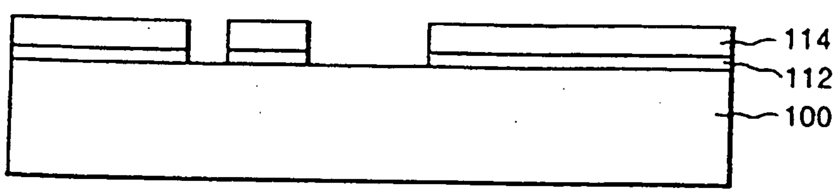

FIG.14

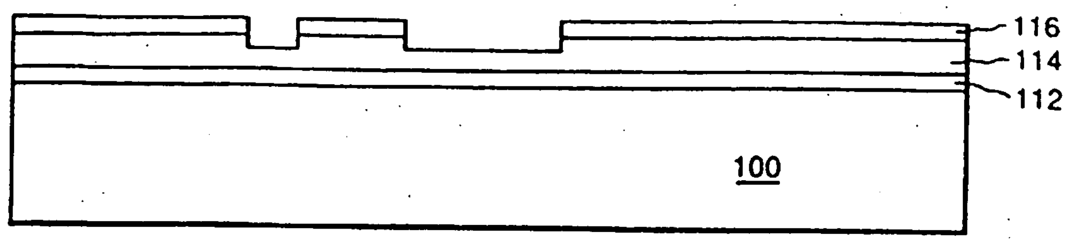

FIG.15

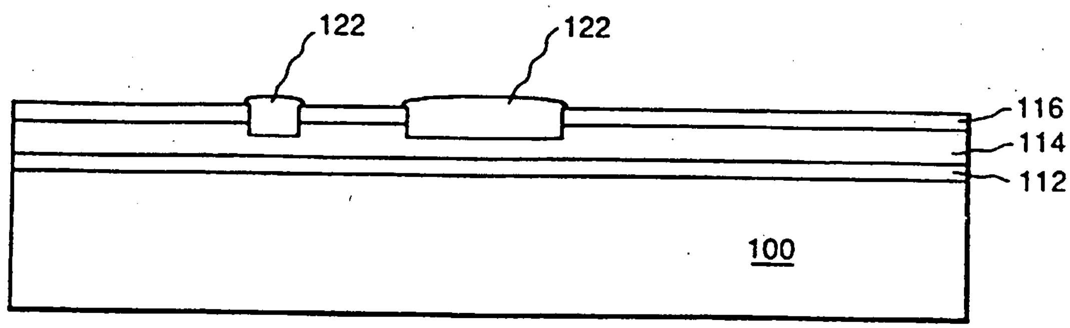

FIG.16

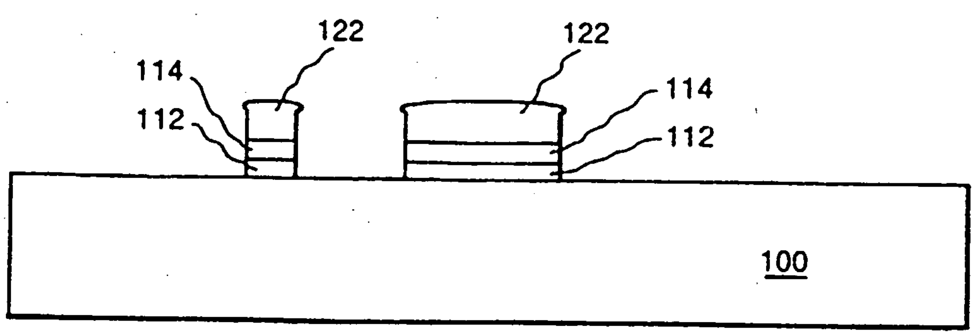

FIG.17

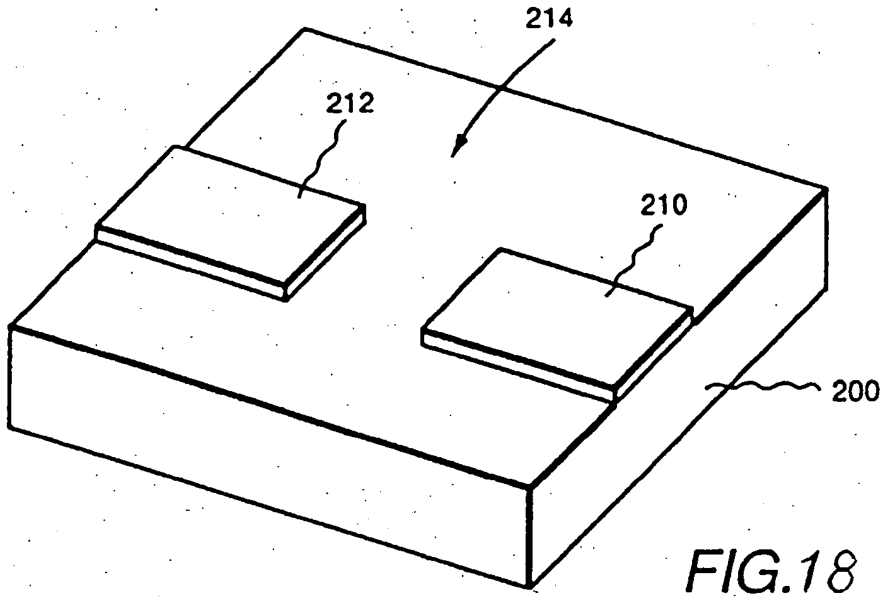

FIG.18

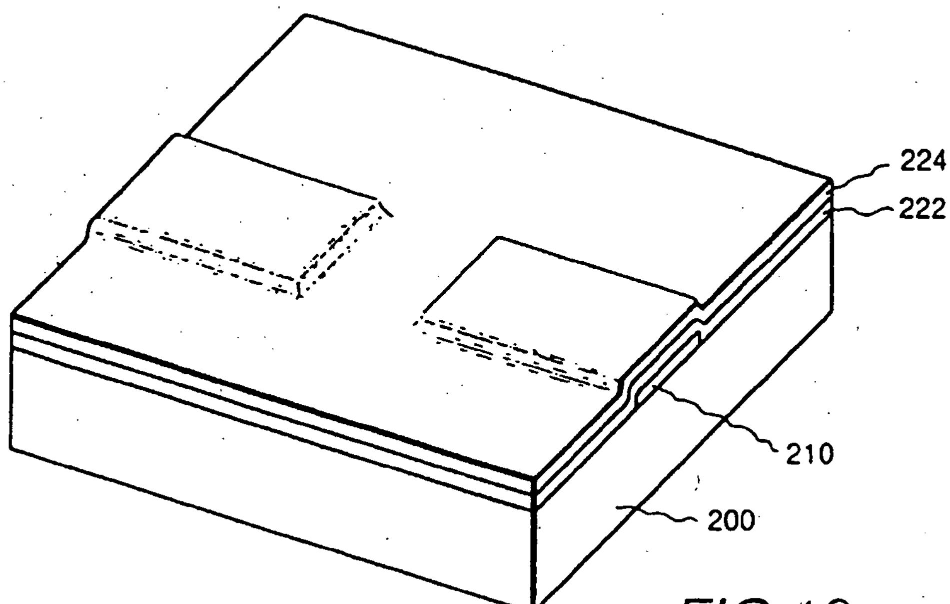

FIG.19

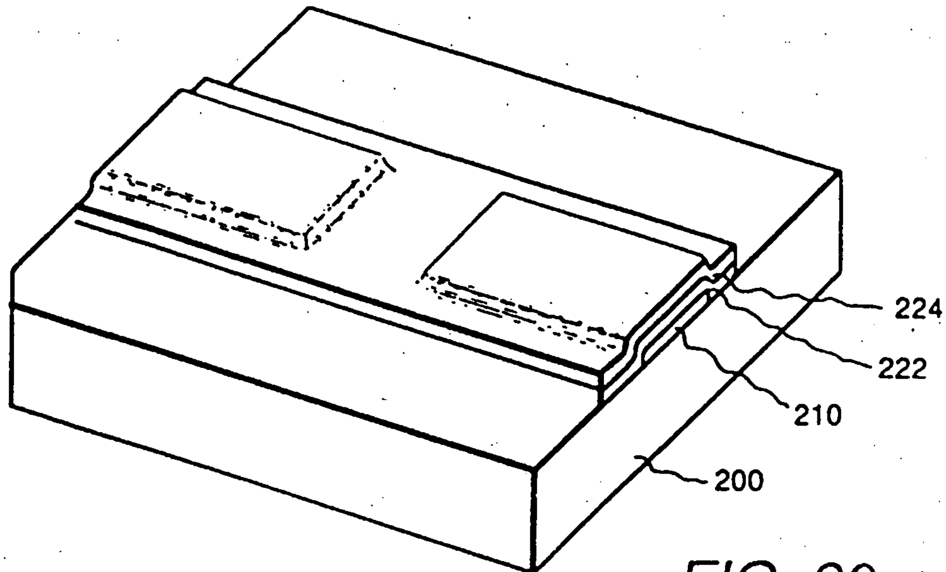

FIG. 20

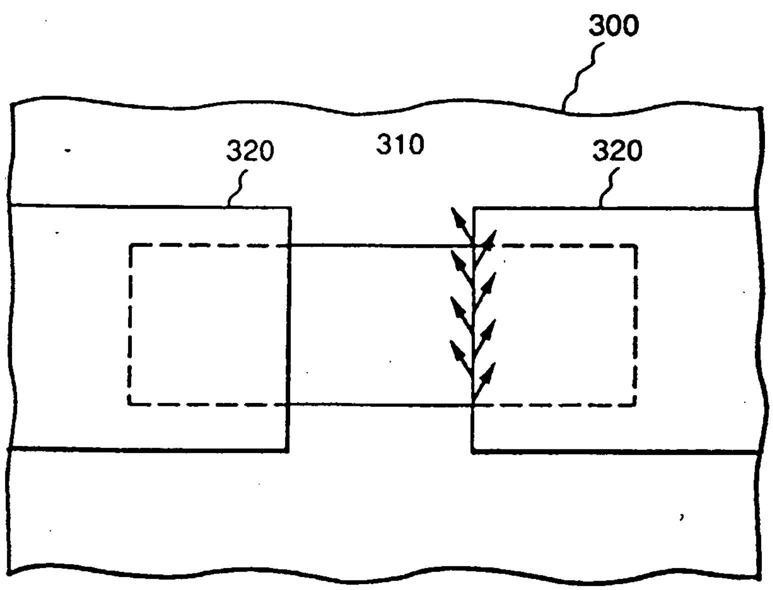

FIG. 21